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1 February 2005
CHRISTCHURCH OFFICE

CONFIRMATION

Confirmation to follow

IP Australia
P O Box 200
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AUSTRALIA

Attention: Leopold Filipovic

Re: PCT PATENT APPLICATION NO. PCT/NZ2003/000236
Rocktec Limited
A DROP HAMMER LOCK
Our ref: 122786 / 32 AH

Thank you for your first Written Opinion dated 1st July 2004.

Referring to that Opinion:

Novelty and inventive step objections

In light of the examiner's objections, the claims have been amended to incorporate features of a number of the original dependant claims into the new main independent apparatus and method claims. A copy of the new claim set is **enclosed** together with corresponding amendments to the description on pages 3-16 (marked up and final copy).

The new claim 1 is directed to an apparatus for connection to an excavator or other machine. Such machines are used with drop hammers, powered drive-down hammers and the like which apply high impact forces to crush and break concrete, rock and other tough materials.

Claim 1 now also incorporates a hammer received within a housing and a drive mechanism for reciprocating the hammer. In its impacting role the

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hammer protrudes from an open lower opening. As emphasised in the specification, it is a disadvantage of the prior art devices that a separate excavator is required rake the material broken by the hammer. This adds significant overheads in terms of manpower, capital investment in separate machines and increased execution time.

The ability to combine the pushing/raking functions of an excavator with the breaking functions of a powered hammer offer clear economic advantages to commercial operators. Moreover, the essential mechanical features of the present invention have been available in their separate forms for a significant period (25+ years) without any combination of these features.

The large forces involved in such machinery prevent simply scaling up ideas from small hand-held tools. In order to lock the hammer against the housing, significant force is required and consequently an appreciable degree of wear can occur at the interface between the locking member and the hammer. The self-tightening design of the locking member provides a means to overcome the effects of wear. The prior art locking mechanisms disclosed need take no such account of wear given the vastly reduced forces involved in such small scale devices.

As is well established, the issue of obviousness must be judged in the context of a person skilled in the art *relevant to the particular industry*. The rock/concrete breaking industry is conservative without continual innovation or fundamental change in the machinery involved. This is primarily because the machinery invoked operates on well-established, fundamental mechanical principles which appear to leave little avenue for improvement.

Thus, in the context of this industry, we submit that had the present invention lacked inventive step, it would have been implemented decades ago. It is only by the ubiquitous 'benefit of hindsight' that the present invention may appear obvious and we thus ask that the objection be withdrawn.

Regarding the prior art citations raised by the examiner, we provide the following comments:

Prior Art

AU 51868/00 *Holmes*
This patent describes a pile or post driver with a drop hammer which slides in a vertical guide and is raised by pressing a pair of friction wheels to engage either side of the drop hammer and rotating the friction wheels by hydraulic motors.

Although the drive arrangement described by *Holmes* could be considered to include a device capable of fixing the hammer in position within the housing (i.e. if the motors are locked from rotating) there is no teaching that the hammer should be fixed to the housing. *Holmes* suggests a specific mechanism for driving the hammer, rather than a machine having a drive mechanism and a separate locking mechanism, as provided in the present invention. There is therefore no teaching by *Holmes* in the direction of the

proposed solution and it is only with hindsight that this document has been revealed.

In the present invention the impacting tool end of the hammer extends through an opening in the end of the housing, and is thus in a position where it can be used for pushing or raking material. The impacting end of the pile driving hammer, on the other hand, is at an intermediate position below the top of the hammer. Given the impacting end of the hammer does not project from an end of the housing at any point in its movement, the tool cannot be used for both impacting and, when locked, for pushing or raking material. Accordingly, to the skilled reader seeking a solution to the problem of how the number of tool changes on the excavator can be reduced during a demolition operation, this document does not suggest solution provided by the present invention.

US 6 109 365 *Lamoureux et al.* and US 2 802 340 *Tallman*

These two patents describe impact-type hand tools of the same general type. Both include an elongated bar with a working head at one end which is slidably received within a sleeve or housing, which may be reciprocated to impact the bar. A hand-operated cam lock and screw thread respectively form the locking mechanisms which lock the bar and sleeve together.

Being hand tools these are much smaller scale tools than the invention and are not adapted for connection to the articulated arm of an excavator, or the like where, because of the significantly larger forces, these manual locking devices are unsuitable. The locking mechanism of the present invention is power-actuated. Moreover these tools operate in quite a different manner to the invention. Rather than reciprocating the hammer, it is the housing which is reciprocated by the user to impact the hammer and so in this respect it teaches away from the present invention, where the housing remains stationary while the hammer is driven. Furthermore, there is no disclosure or suggestion in either document of how a drive mechanism could be provided for reciprocating the hammer. Given these differences, including the different scale of the tools, the different manner of operation and lack of a drive mechanism, a person skilled in the art who is aware of the prior art and seeking to solve the above-mentioned problem would not consider these documents to be of particular relevance. Lastly, the locking mechanism of the present invention is not disclosed and does not tend to rotate to increase the clamping force when the hammer is pressed into the housing.

US 5 462 126 *Wallace*

Wallace describes an apparatus for driving a rod and includes a tubular housing for receiving the rod, one end of which may be engaged with a prime mover. A ratchet device fixed to the outer tube engages the rod when the housing is driven downward, releasing it when the housing is raised. A series of downward thrusts of the prime mover inserts the rod.

As per AU 51868/00 discussed above, this document suggests a specific mechanism for driving the hammer, rather than a machine having a drive mechanism and a separate locking mechanism, as provided in the present

invention. Also, as per US 6 109 365 and US 2 802 340 this arrangement also teaches away from the hammer itself being reciprocated. This tool does not include a hammer which is reciprocated or a drive mechanism for reciprocating the hammer, rather it is the housing which is reciprocated by an external drive mechanism. Moreover, the "locking mechanism" is a ratchet-type and thus only prevents movement of the hammer in one direction, rather than fixing the hammer to the housing.

SU 1 254 116 *Sivkov*

Sivkov describes an impactor where the hammer is reciprocated using two rotary drivers.

There is no disclosure or suggestion in this patent of a locking mechanism for fixing the hammer within the housing. The ratchet described cannot be considered a locking mechanism as it only prevents movement of the hammer in one direction, rather than fixing the hammer to the housing.

SU 586 240 *Matveev et al*

The impactor disclosed by *Matveev* is of a type with a reciprocating drop hammer received within a housing and a driving mechanism including a loop of chain with a projecting pin that engages the weight to lift the weight, which then drops to impact the working surface.

There is no description by *Matveev* of a locking mechanism for fixing the hammer to the housing. It appears from the abstract that the hammer is retained within the housing and drops to strike the block 14, the bottom face of which contacts the working surface. The block 14 is fixed at the base of the housing and thus the hammer itself does not strike the working surface, as per the present invention. Thus, the driving mechanism used by *Matveev* is incompatible with the present invention as locking the hammer constrained within the housing would achieve no useful purpose. It is thus submitted *Matveev* teaches away from the solution of the problem addressed by the present invention.

The applicant respectfully submits that the above amendments and arguments overcome the Examiner's objections, and we look forward to receiving the International Preliminary Examination Report in due course.

Yours sincerely
JAMES & WELLS

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motion as th[redacted]re not secured to the hammer housing.[redacted]

It should be appreciated that while drop hammer devices are not designed to be used in a raking motion, they can be operated at angles substantially away from the vertical plane. This freedom of movement away from the vertical allows drop hammer devices to be used to break uneven portions of concrete, and low lying walls or the like and extends the number of places a drop hammer device can be utilised.

A prior art breaker of the applicant's design is used in demolition work connected to an articulated arm of an excavator, skid steer or like machine. The breaker has a housing in which a drop hammer is received. A drive mechanism, enclosed in the housing includes a loop of chain having a dog fixed thereto and a motor for rotating the chain, the dog abutting a projection on the hammer to raise the hammer, moving it away from an opening end of the housing. The hammer is then dropped to extend from opening end of the housing to impact the working surface. Although this tool performs satisfactorily, a number of tool changes on the excavator (e.g. swapping the breaker with a bucket) are required during a demolition operation since the breaker cannot be used for pushing or raking broken material to clear the work area.

All references, including any patents or patent applications cited in this specification are hereby incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents form part of the common general knowledge in the art, in New Zealand or in any other country.

It is acknowledged that the term 'comprise' may, under varying jurisdictions, be

attributed with either an exclusive or an inclusive meaning. For the purpose of this specification, and unless otherwise noted, the term 'comprise' shall have an inclusive meaning - i.e. that it will be taken to mean an inclusion of not only the listed components it directly references, but also other non-specified components or elements. This rationale will also be used when the term 'comprised' or 'comprising' is used in relation to one or more steps in a method or process.

It is an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

DISCLOSURE OF INVENTION

~~According to one aspect of the present invention there is provided a method of securing a shaft at any point along its substantially vertical axis of movement, including a locking device,~~

~~wherein the locking device has at least one face that is moveable with respect to the shaft, the method characterised by the step of~~

~~a) moving the locking device into a position wherein at least one face of the locking device mates against at least one point on the shaft so as to secure the shaft at any point along its substantially vertical axis of movement.~~

According to one aspect, the present invention provides an apparatus for connection to an excavator or other machine, the apparatus including:

- a hammer having an impacting end for impacting a working surface;
- a drive mechanism for reciprocating the hammer;

- housing in which the hammer is received, the housing being configured for attachment to said machine, the impacting end of the hammer extending in use from an open end of the housing;

- a locking mechanism including a locking member and an actuator,

characterised in that the actuator is capable of forcing a hammer-engaging face of the locking member to engage at one or more points along a face of the hammer to lock the hammer within the housing such that the impacting end protrudes from the open end of the housing, thereby allowing the protruding end of the hammer to also be used for pushing or raking material.

The term '~~shaft~~ hammer' in accordance with the present invention should be understood to mean an elongated block or pole that can be moved along a substantially vertical axis. It should be appreciated that the axis can be angled up to approximately 89° either side of vertical as desired. However, this angling of the ~~shaft~~ hammer can only be achieved when the ~~shaft~~ hammer and its housing are moved as a single unit. The ~~shaft~~ hammer itself has some freedom of movement within its housing, but only sufficient to allow for normal activity, as known to someone skilled in the art.

~~In preferred embodiments the shaft is an elongated block that is formed into a hammer, t~~The hammer ~~being~~ is an elongated piece of heavy material designed to be pounded into an area to result in failure of the material underneath, be it concrete, building material, rock, ground, or the like. However, these are listed by way of example only and should not be seen to be limiting.

~~For ease of reference, the shaft shall now be referred to as a hammer throughout the specification however this should not be seen to be limiting.~~

It should be appreciated that the hammer can be enclosed within a housing, the

housing including a mechanism configured to lift the hammer to a raised position. Once the hammer is in the raised position it can be released and due to the weight of the hammer, gravity will accelerate the hammer into the area beneath the hammer, imparting a large impact force and breaking or weakening whatever is situated beneath the impact zone.

It should further be appreciated that the hammer could be in the shape of a cylinder or an elongated box with multiple faces, or variation thereof as these are listed by way of example only and should not be seen to be limiting.

In preferred embodiments the hammer is an elongated vertical column with multiple faces.

It should be appreciated that the hammer does not normally include any internal attaching means to secure the hammer to the hammer housing, instead the hammer is held in place by the hammer housing, but it is not usually physically attached to it. Upon activation, the raising of the hammer can be undertaken by any number of mechanisms that impart lift. The mechanisms used to lift the hammer into position are known to someone skilled in the art and can include a cable attached to the upper end of the hammer or a chain and dog arrangement that engages a protrusion that extends from the hammer itself, however these are listed by way of example only.

In one embodiment, the locking member is a cam and the actuator pivots the cam to press a hammer-engaging face of the cam to engage with a face of the hammer to lock the hammer within the housing, the cam being shaped such that any force acting to pushing the hammer into the housing with the locking mechanism engaged acts to rotate the cam and thereby hold the hammer more firmly.

Preferably, the locking member engages with a face of the hammer by rotation

about a first axis of rotation, the locking member having an eccentric rotational peripheral profile about said first axis of rotation.

According to one aspect of the present invention, rotation of the locking member in the engaged position due to upward movement of the hammer increases the force of engagement engaged between the locking member and the hammer.

Preferably, said rotation causes portions of the eccentric peripheral profile with an increasing radius into contact with the hammer.

In a further embodiment the actuator causes rotation of the locking member about said first axis of rotation via at least one intermediate linkage, pivotally attached about a second and third axis of rotation to the locking member and actuator respectively.

Preferably, a projection is provided on the hammer and the drive mechanism includes a loop of chain having at least one dog fixed thereto and a motor for rotating the chain, the dog abutting the projection to move the hammer away from the opening end of the housing.

The drive mechanism is preferably mounted within the housing.

Preferably, both the drive mechanism and actuator are hydraulically powered.

According to a preferred embodiment, the apparatus is connected to an excavator or other machine via an articulated arm.

The term 'dog' in accordance with the present invention should be understood to mean a catch physically attached to the chain that protrudes outwards, and will engage any protrusion extending from the drop hammer. The term 'dog' is known to someone skilled in the art, but should not be seen to be limiting.

According to a further aspect, the present invention provides a method of locking a hammer in an apparatus, substantially as hereinbefore described, within the housing such that the impacting end protrudes from the open end of the housing, thereby allowing the protruding end of the hammer to be used for pushing and/or raking material, said method including;

- activating the actuator to engage a hammer-engaging face of the locking member at a point along a face of the hammer to lock the hammer to the housing.

According to a yet further aspect, the present invention provides a method of locking a hammer within the housing of an apparatus adapted for connection to an excavator or other machine to allow an impacting end of the hammer to protrude from the open end of the housing enabling the protruding end of the hammer to be used for pushing and/or raking material, the apparatus including:

- a hammer having an impacting end for impacting a working surface;
- a drive mechanism for reciprocating the hammer;
- a housing in which the hammer is received, the housing being configured for attachment to said machine, the impacting end of the hammer extending in use from an open end of the housing;
- a locking mechanism including a locking member and an actuator,

said method including;

- activating the actuator to engage a hammer-engaging face of the locking member at a point along a face of the hammer to lock the hammer to the housing.

Preferably, the hammer-engaging face of the locking member engages the hammer at any selected point along at least a portion of a hammer face.

The term 'protrusion' in accordance with the present invention should be understood to mean at least one extension of a portion of the drop hammer out to the side of the drop hammer so it is available to be engaged by the dog.

~~Once engag[redacted] the upward movement of the chain w[redacted]ift the dog and the drop hammer along with it.~~

It should be appreciated that there can be more than one protrusion which can be positioned on any vertical side of the drop hammer.

In preferred embodiments, the mechanism used to lift the hammer into its peak vertical position is the chain and dog arrangement. The chain rotates around at least two sprockets positioned lengthwise to the drop hammer. The chain has at least one dog attached to it that engages the protrusion, or protrusions positioned on the hammer. As the chain is rotated, the hammer will lift as the dog attached to the chain rises. As the hammer reaches its maximum vertical height, the dog attached to the chain rotates around the sprocket and the hammer is released as the protrusion is positioned to the side of the sprocket.

It should be appreciated that any locking device could be positioned to abut against any point anywhere on the hammer.

It should also be appreciated that the vertically rotating chain could either be parallel with or perpendicular to the hammer. Accordingly, any locking device could be positioned between the rotating chain, as the chain would, in preferred embodiments, be oriented parallel to the hammer, rather than perpendicular to it in order to reduce the overall size of the hammer housing and therefore the overall weight of the unit as a whole.

The term 'locking device' in accordance with the present invention should be understood to mean a friction-based lock such as a cam, magnet or any locking means that utilises the onset of friction between two faces as they mate together to lock an item into a position, although these are listed by way of example only and should not be seen to be limiting.

motion as they are not secured to the hammer housing.

It should be appreciated that while drop hammer devices are not designed to be used in a raking motion, they can be operated at angles substantially away from the vertical plane. This freedom of movement away from the vertical allows drop hammer devices to be used to break uneven portions of concrete, and low lying walls or the like and extends the number of places a drop hammer device can be utilised.

A prior art breaker of the applicant's design is used in demolition work connected to an articulated arm of an excavator, skid steer or like machine. The breaker has a housing in which a drop hammer is received. A drive mechanism, enclosed in the housing includes a loop of chain having a dog fixed thereto and a motor for rotating the chain, the dog abutting a projection on the hammer to raise the hammer, moving it away from an opening end of the housing. The hammer is then dropped to extend from opening end of the housing to impact the working surface. Although this tool performs satisfactorily, a number of tool changes on the excavator (e.g. swapping the breaker with a bucket) are required during a demolition operation since the breaker cannot be used for pushing or raking broken material to clear the work area.

All references, including any patents or patent applications cited in this specification are hereby incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents form part of the common general knowledge in the art, in New Zealand or in any other country.

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attributed with either an exclusive or an inclusive meaning. For the purpose of this specification, and unless otherwise noted, the term 'comprise' shall have an inclusive meaning - i.e. that it will be taken to mean an inclusion of not only the listed components it directly references, but also other non-specified components or elements. This rationale will also be used when the term 'comprised' or 'comprising' is used in relation to one or more steps in a method or process.

It is an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

DISCLOSURE OF INVENTION

According to one aspect, the present invention provides an apparatus for connection to an excavator or other machine, the apparatus including:

- a hammer having an impacting end for impacting a working surface;
- a drive mechanism for reciprocating the hammer;
- a housing in which the hammer is received, the housing being configured for attachment to said machine, the impacting end of the hammer extending in use from an open end of the housing;
- a locking mechanism including a locking member and an actuator,

characterised in that the actuator is capable of forcing a hammer-engaging face of the locking member to engage at one or more points along a face of the hammer to lock the hammer within the housing such that the impacting end protrudes from the open end of the housing, thereby allowing the protruding end of the hammer to also be used for pushing or raking material.

The term 'hammer' in accordance with the present invention should be understood to mean an elongated block or pole that can be moved along a substantially vertical axis. It should be appreciated that the axis can be angled up to approximately 89° either side of vertical as desired. However, this angling of the hammer can only be achieved when the hammer and its housing are moved as a single unit. The hammer itself has some freedom of movement within its housing, but only sufficient to allow for normal activity, as known to someone skilled in the art.

The hammer is an elongated piece of heavy material designed to be pounded into an area to result in failure of the material underneath, be it concrete, building material, rock, ground, or the like. However, these are listed by way of example only and should not be seen to be limiting. It should be appreciated that the hammer can be enclosed within a housing, the housing including a mechanism configured to lift the hammer to a raised position. Once the hammer is in the raised position it can be released and due to the weight of the hammer, gravity will accelerate the hammer into the area beneath the hammer, imparting a large impact force and breaking or weakening whatever is situated beneath the impact zone.

It should further be appreciated that the hammer could be in the shape of a cylinder or an elongated box with multiple faces, or variation thereof as these are listed by way of example only and should not be seen to be limiting.

In preferred embodiments the hammer is an elongated vertical column with multiple faces.

It should be appreciated that the hammer does not normally include any internal attaching means to secure the hammer to the hammer housing, instead the hammer is held in place by the hammer housing, but it is not usually physically attached to it. Upon activation, the raising of the hammer can be undertaken by any number of

mechanisms [redacted] impart lift. The mechanisms used to [redacted] hammer into position are known to someone skilled in the art and can include a cable attached to the upper end of the hammer or a chain and dog arrangement that engages a protrusion that extends from the hammer itself, however these are listed by way of example only.

In one embodiment, the locking member is a cam and the actuator pivots the cam to press a hammer-engaging face of the cam to engage with a face of the hammer to lock the hammer within the housing, the cam being shaped such that any force acting to pushing the hammer into the housing with the locking mechanism engaged acts to rotate the cam and thereby hold the hammer more firmly.

Preferably, the locking member engages with a face of the hammer by rotation about a first axis of rotation, the locking member having an eccentric rotational peripheral profile about said first axis of rotation.

According to one aspect of the present invention, rotation of the locking member in the engaged position due to upward movement of the hammer increases the force of engagement engaged between the locking member and the hammer.

Preferably, said rotation causes portions of the eccentric peripheral profile with an increasing radius into contact with the hammer.

In a further embodiment the actuator causes rotation of the locking member about said first axis of rotation via at least one intermediate linkage, pivotally attached about a second and third axis of rotation to the locking member and actuator respectively.

Preferably, a projection is provided on the hammer and the drive mechanism includes a loop of chain having at least one dog fixed thereto and a motor for rotating the chain, the dog abutting the projection to move the hammer away from

the opening end of the housing.

The drive mechanism is preferably mounted within the housing.

Preferably, both the drive mechanism and actuator are hydraulically powered.

According to a preferred embodiment, the apparatus is connected to an excavator or other machine via an articulated arm.

The term 'dog' in accordance with the present invention should be understood to mean a catch physically attached to the chain that protrudes outwards, and will engage any protrusion extending from the drop hammer. The term 'dog' is known to someone skilled in the art, but should not be seen to be limiting.

According to a further aspect, the present invention provides a method of locking a hammer in an apparatus, substantially as hereinbefore described, within the housing such that the impacting end protrudes from the open end of the housing, thereby allowing the protruding end of the hammer to be used for pushing and/or raking material, said method including;

- activating the actuator to engage a hammer-engaging face of the locking member at a point along a face of the hammer to lock the hammer to the housing.

According to a yet further aspect, the present invention provides a method of locking a hammer within the housing of an apparatus adapted for connection to an excavator or other machine to allow an impacting end of the hammer to protrude from the open end of the housing enabling the protruding end of the hammer to be used for pushing and/or raking material, the apparatus including:

- a hammer having an impacting end for impacting a working surface;

- a drive mechanism for reciprocating the hammer;

- a housing in which the hammer is received, the housing being configured for attachment to said machine, the impacting end of the hammer extending in use from an open end of the housing;

- a locking mechanism including a locking member and an actuator,

said method including;

- activating the actuator to engage a hammer-engaging face of the locking member at a point along a face of the hammer to lock the hammer to the housing.

Preferably, the hammer-engaging face of the locking member engages the hammer at any selected point along at least a portion of a hammer face.

The term 'protrusion' in accordance with the present invention should be understood to mean at least one extension of a portion of the drop hammer out to the side of the drop hammer so it is available to be engaged by the dog.

It should be appreciated that there can be more than one protrusion which can be positioned on any vertical side of the drop hammer.

In preferred embodiments, the mechanism used to lift the hammer into its peak vertical position is the chain and dog arrangement. The chain rotates around at least two sprockets positioned lengthwise to the drop hammer. The chain has at least one dog attached to it that engages the protrusion, or protrusions positioned on the hammer. As the chain is rotated, the hammer will lift as the dog attached to the chain rises. As the hammer reaches its maximum vertical height, the dog attached to the chain rotates around the sprocket and the hammer is released as the protrusion is positioned to the side of the sprocket.

It should be appreciated that any locking device could be positioned to abut against

any point anywhere on the hammer.

It should also be appreciated that the vertically rotating chain could either be parallel with or perpendicular to the hammer. Accordingly, any locking device could be positioned between the rotating chain, as the chain would, in preferred embodiments, be oriented parallel to the hammer, rather than perpendicular to it in order to reduce the overall size of the hammer housing and therefore the overall weight of the unit as a whole.

The term 'locking device' in accordance with the present invention should be understood to mean a friction-based lock such as a cam, magnet or any locking means that utilises the onset of friction between two faces as they mate together to lock an item into a position, although these are listed by way of example only and should not be seen to be limiting.

By using a friction based locking device, the likelihood of damage to the locking device or the mechanism around it is reduced. If a pin based locking device where a pin enters a recess were used, the likelihood of the pin shearing over time due to impact wear would be higher. If the locking device was activated while the hammer was moving, any pin based locking device would more than likely be sheared off due to the downward force of the hammer. The use of a friction based locking device would mean that even if the lock were activated while the hammer was falling, the friction created by the two faces meeting would only serve to slow the hammer down and lock it into place, not shear the cam off it's rotational axis, although it is not envisaged that the lock would be engaged while the hammer is in vertical fall.

It is an advantage of a friction-based lock that there is a reduced likelihood of damage to the lock due to shearing or the like.

The term 'cam' is a term known to someone skilled in the art and refers to a substantially flat projection on a rotating part in machinery.

In preferred embodiments the locking means is a cam configured so that on activation the cam will rotate and the substantially flat face will turn and meet, or mate with the face of the hammer at whatever position the hammer is in.

Cams are versatile and will allow slip between the two 'mating' faces should the force applied to the hammer overcome the strength of the lock. This slip therefore reduces the likelihood of destruction of the locking means in unusual circumstances.

It should also be appreciated that cams can be self tightening. As the rotation of the cam is in a clockwise direction to bring the substantially flat face up against the hammer, any upward pressure of the hammer against the cam face will only serve to tighten the lock.

It is also an advantage of this type of locking means that the hammer can be secured at any height. The length of protrusion of the hammer out of the hammer housing can therefore be varied as desired by the excavator operator.

This is a distinct advantage over any locking mechanism that uses a pin and recess arrangement. Either recesses must be positioned at multiple points along the hammer, or there limited locking positions available. A friction based locking means can be activated at any point along the length of the hammer.

If the operator is using the hammer to break material, the hammer itself can be secured with any desired portion of the hammer extending out of the hammer housing. If the broken material is of a thicker nature, a larger portion of the hammer can be set to protrude from the hammer housing. The material can then be raked or moved in the horizontal motion to one side so that other machines can work alongside the hammer mechanism to remove the material.

This has a distinct advantage over the prior art as it allows both hammer and removal machines to work concurrently rather than consecutively. This has key advantages in reducing the costs to undertake a job as the time to complete the job is faster.

Another advantage of the present invention is that the addition of a locking mechanism allows a single machine to do the job of two machines. Both hammering and raking can be undertaken by the same machine, saving time and money and potentially increasing the safety of a worksite due to less heavy machinery working in a demolition site.

The ability to lock the hammer at any desired protrusion length is a further advantage in that the hammer length can be set to provide the operator with maximum visibility, therefore increasing operator comfort. The operator can also lock the hammer at any length, making the job effectively easier as there is less likelihood of damaging the hammer through incorrect usage.

The ability to lock the hammer in any desired position along its vertical axis is a distinct advantage over any standard drop hammer device as the drop hammer is usually not attached to any hammer housing. As such, any pressure applied to the hammer will push it back up into the housing, making raking or sweeping of material impossible.

In other embodiments, the locking means could be a mating face with a negative gradient that abuts a specially configured mating face on the hammer with a positive gradient. When the mating face of the locking means is rotated to abut the hammer the hammer is locked in place.

The direction of the slope of each mating face is important as if the hammer receives a knock, the locking means will tighten rather than release.

According to another aspect of the present invention there is provided a locking device for reversibly locking a hammer at any point along its substantially vertical axis of movement

wherein the locking means has a mating face, that once activated, will position itself against the mating face of the hammer to secure it in position.

The term 'mating face' in accordance with the present invention should be understood to mean the substantially flat surface of one portion of the locking means as one half of the pair of mating faces, and the substantially flat surface of the vertical portion of the hammer.

While the locking means utilises friction in order to secure the hammer in place, the pressure provided to the mating faces to increase friction to initiate locking can be undertaken by a number of means.

In preferred embodiments, a cam is used as the locking means. The rotation of the cam can be controlled by a hydraulic system.

The advantage of controlling the movement of the cam by hydraulics is that the hydraulics controlling the main housing can be tapped into to provide the further controlling means for the cam, therefore simplifying the addition of the locking device to drop hammer devices already in use.

Another advantage of using hydraulics to control the cam is that the abutment of the mating faces is by pressure, the preferred outcome of hydraulic application.

It is envisaged that when the hammer is being used as originally intended; moving through a substantially vertical trajectory, the locking means will remain in the unlocked position with the hydraulic controls in the off position. This will keep the two mating faces separate from each other and allow the hammer to fulfil its job.

It should be appreciated that it would be virtually impossible to lock the hammer in place while the hammer is operating as the hydraulic controls that activate the cam lock also activate the hammer itself. For one to work the other must be non-operational, therefore making it physically impossible to work the lift and lock mechanism at the same time, which reduces the likelihood of unintentional damage to the machine.

It should however be appreciated that the hammer could be used at any angle away from the vertical, provided there is sufficient force provided by gravity or some other propulsion means.

When the control means in the cab of the carrier is activated, therefore engaging either a forward or sideways motion to the carrier and therefore the hammer itself, the hydraulic mechanism will be activated, the cam rotated and the hammer locked in place.

Accordingly, whatever position the hammer is in with respect to the hammer housing at the time of activation of the cam, the hammer will be locked into that position.

It should therefore be appreciated that the height of the hammer can be easily varied by pausing the vertical lift of the hammer housing and activating the cam.

It should also be appreciated that the hammer could be rested on the ground and the hammer housing moved with respect to it to push the hammer into the housing to the desired distance.

It is an advantage of the present invention that the drop hammer device itself has, by the addition of a lock, become a complete tool for both the breaking and moving of material. The end of the hammer is not only used for its impact, but also to rake material away from the work zone.

It is the inventor's opinion that a locking means designed to secure a hammer in a desired position to allow a raking or pushing movement has never been undertaken before. The combination of the locking means with the hammer means that a job undertaken by a drop hammer device can be completed in shorter time because not only can broken material be dragged to one side, but a larger partially broken piece could also be positioned for a second impact, making the job of the assisting machinery easier.

BRIEF DESCRIPTION OF DRAWINGS

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic illustration of a preferred embodiment of the present invention; and

Figure 2 is a diagrammatic representation of a preferred embodiment of the present invention showing a cam as the locking device, and

Figure 3 is a close-up of the diagrammatic representation of one preferred embodiment of the present invention.

BEST MODES FOR CARRYING OUT THE INVENTION

With reference to figure 1, there is illustrated a hammer (1), encased within a hammer housing (2) which is attached to a hydraulic excavator generally indicated by arrow 3.

Also illustrated in figure 1 is the hydraulic activation means (4) for use to engage the locking device (not shown in this figure).

With respect to figure 2 there is shown a close-up of a drop hammer device generally indicated by arrow 5. The drop hammer device 5 consists of a hammer (6), a raising mechanism generally indicated by arrow 7 in the form of a rotating chain (8), two end sprockets (9 a and b), a protrusion (10), a cam lock (11), a hydraulic activating means (12) and a hammer housing (2).

With respect to figure 3, there is shown a close-up of the cam lock (11) and the hydraulic activating means (12). Also shown are the rotating chain lower sprocket (9b), the protrusion (10), the hammer (6) and the hammer housing (2).

When the hammer (6) is operating, the rotating chain (8) containing at least one dog (not shown) rotates.

The dog abuts the protrusion (10) situated on the side of the hammer perpendicular to the rotating chain (8).

As the chain (8) rotates, the dog rises, lifting the protrusion (10) which in turn raises the hammer (6).

When the protrusion (10) rises to a point level with the upper sprocket (9a), the dog rotates over the top of the upper sprocket (9a) and releases the protrusion (10), allowing the hammer to fall.

When the hammer (6) has completed its fall, the dog will rotate around the chain (8) and then abut the protrusion (10) and repeat the vertical lift.

In order to lock the hammer (6) in any position along it's trajectory, the cam (11) is rotated around its axis (13) by means of an actuator (14) which is controlled by the hydraulic activating means (12).

The actuator (14) is made up of two parts that pivot at the joint (15). The forward motion of the actuator (14) combined with the pivoting of the actuator at it's joint (15)

allow the cam (11) to rotate to engage the hammer (6). This means that the hammer can be engaged at any point along its trajectory.

Once the hammer (6) is locked in a position by the cam (11) it can then be used at any angle, rather than just vertical, to rake material or position material for further impacting.

The operator can initiate the engagement of the cam (11) by activation of the hydraulic activating means (12) from inside the hydraulic excavator.

It should also be appreciated that the initiating of the cam (11) will either disengage or halt the raising mechanism (7), or push the hammer (6) away from the raising mechanism (7) and up against the far side of the hammer housing (12) so that the catch mechanism cannot engage the protrusion (10) and raise the hammer (1).

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof.

CLAIMS:

1. An apparatus for connection to an excavator or other machine, the apparatus including:
   - a hammer having an impacting end for impacting a working surface;
   - a drive mechanism for reciprocating the hammer;
   - a housing in which the hammer is received, the housing being configured for attachment to said machine, the impacting end of the hammer extending in use from an open end of the housing;
   - a locking mechanism including a locking member and an actuator,

   characterised in that the actuator is capable of forcing a hammer-engaging face of the locking member to engage at one or more points along a face of the hammer to lock the hammer within the housing such that the impacting end protrudes from the open end of the housing, thereby allowing the protruding end of the hammer to also be used for pushing or raking material.

2. The apparatus as claimed in claim 1 wherein the locking member is a cam and the actuator pivots the cam to press a hammer-engaging face of the cam to engage with a face of the hammer to lock the hammer within the housing, the cam being shaped such that any force acting to pushing the hammer into the housing with the locking mechanism engaged acts to rotate the cam and thereby hold the hammer more firmly.

3. The apparatus as claimed in claim 1 or claim 2 wherein the locking member engages with a face of the hammer by rotation about a first axis of rotation, the locking member having an eccentric rotational peripheral profile about said first axis of rotation.

4. The apparatus as claimed in claim 3, wherein rotation of the locking member in the engaged position due to upward movement of the hammer increases the force of engagement engaged between the locking member and the hammer.

5. The apparatus as claimed in claim 4, wherein said rotation causes portions of the eccentric peripheral profile with an increasing radius into contact with the hammer.

6. The apparatus as claimed in any one of claims 3-5, wherein the actuator causes rotation of the locking member about said first axis of rotation via at least one intermediate linkage, pivotally attached about a second and third axis of rotation to the locking member and actuator respectively.

7. The apparatus as claimed in any one of the preceding claims wherein a projection is provided on the hammer and the drive mechanism includes a loop of chain having at least one dog fixed thereto and a motor for rotating the chain, the dog abutting the projection to move the hammer away from the opening end of the housing.

8. The apparatus as claimed in any one of the preceding claims wherein the drive mechanism is mounted within the housing.

9. The apparatus as claimed in any one of the preceding claims wherein both the drive mechanism and actuator are hydraulically powered.

10. The apparatus as claimed in any one of the preceding claims wherein the apparatus is connected to an excavator or other machine via an articulated arm.

11. A method of locking a hammer in an apparatus as claimed in any one of claims 1-10 within the housing such that the impacting end protrudes from the open end of the housing, thereby allowing the protruding end of the hammer to be used for pushing and/or raking material, said method including;

- activating the actuator to engage a hammer-engaging face of the locking member at a point along a face of the hammer to lock the hammer to the housing.

12. A method of locking a hammer within the housing of an apparatus adapted for connection to an excavator or other machine to allow an impacting end of the hammer to protrude from the open end of the housing enabling the protruding end of the hammer to be used for pushing and/or raking material, the apparatus including:

- a hammer having an impacting end for impacting a working surface;
- a drive mechanism for reciprocating the hammer;
- a housing in which the hammer is received, the housing being configured for attachment to said machine, the impacting end of the hammer extending in use from an open end of the housing;
- a locking mechanism including a locking member and an actuator,

said method including;

- activating the actuator to engage a hammer-engaging face of the locking member at a point along a face of the hammer to lock the hammer to the housing.

13. The method as claimed in claim 11 or claim 12, wherein the hammer-engaging face of the locking member engages the hammer at any selected point along at least a portion of a hammer face.

ABSTRACT

The present invention relates to a method of securing a shaft at any point along its substantially vertical axis of movement, wherein the method includes a locking device that is moveable with respect to the shaft. The method is characterised by the step of moving the locking device into a position wherein at least one face of the locking device mates against at least one point on the shaft so as to secure the shaft at any point along its substantially vertical axis of movement. In particular this invention relates to a method of securing a drop hammer at any point along its substantially vertical axis by use of a hydraulically controlled cam.